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CLAIMS

1 1. A gradient domain compression system for generating, from an input image having a high
2 luminance dynamic range, an output image having a lower luminance dynamic range, the system
3 comprising:

- 4 A. a gradient image generator module configured to generate, from the input image, a gradient
5 image representing, for respective points of the input image, gradient values in the luminance
6 of the input image;
- 7 B. a gradient compression module configured to receive the gradient image and generate a
8 compressed range gradient image in which the range of gradient values are compressed; and
- 9 C. an output image generator module configured to receive the compressed range gradient
0 image and to generate therefrom an image, the image generated by the output image
1 generator module comprising the output image.

1 2. A system as defined in claim 1 in which the gradient compression module comprises:

- 2 A. a gradient attenuation function generator module configured to generate, for respective points
3 in the gradient image, a gradient attenuation function whose value for respective points in
4 the gradient image is configured to reduce the range of gradient values in the gradient image;
5 and
- 6 B. an attenuated image gradient generator module configured to generate, from the gradient
7 image and the gradient attenuation function, the compressed range gradient image.

1 3. A system as defined in claim 2 in which the gradient attenuation function generator module is
2 configured to generate the gradient attenuation function to provide values for respective points of

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3 the gradient image so as to reduce relatively high gradient values in a progressive manner, such that
4 higher gradient values are reduced more than lower gradient values.

1 4. A system as defined in claim 2 in which the gradient attenuation function generator module is
2 configured to generate the gradient attenuation function to provide values for respective points of
3 the gradient image so as to increase relatively low gradient values in a progressive manner, such that
4 lower gradient values are increased more than higher gradient values.

1 5. A system as defined in claim 2 in which the gradient attenuation function generator module is
2 configured to generate the gradient attenuation function whose value for respective points in the
3 gradient image is configured to reduce the range of gradient values in the gradient image around a
4 selected gradient value in the gradient image.

1 6. A system as defined in claim 2 in which the gradient attenuation function generator comprises:

2 A. a Gaussian pyramid generator module configured to generate a Gaussian pyramid comprising
3 a series of levels, each level of the Gaussian pyramid comprising a level gradient image
4 having a reduced resolution than the level gradient image of the preceding level in the series;

5 B. a level scaling factor generator module configured to generate, for respective levels gradient
6 images of the Gaussian pyramid, a respective level scaling factor representative of the
7 gradient attenuation function at the particular level; and

8 C. a scaling factor propagator module configured to propagate the level scaling factors through
9 the Gaussian pyramid, thereby to generate the gradient attenuation function for use by the
0 attenuated image gradient generator module.

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1 7. A system as defined in claim 1 in which output image generator module is configured to generate
2 the output image as the image that is close to the compressed range gradient image in a least-squares
3 sense.

1 8. A system as defined in claim 7 in which the output image generator module is configured to
2 generate the output image in such that the Laplacian of the output image corresponds to the
3 divergence of the compressed range gradient image.

1 9. A system as defined in claim 1 further comprising a preprocessor module configured to generate,
2 in response to the input image, a preprocessed image comprising the logarithm of the input image,
3 the gradient image generator module being configured to use the preprocessed image as its input
4 image.

1 10. A system as defined in claim 1 further comprising a post-processor module configured to
2 generate, in response to the output image generated by the output image generator module, a post-
3 processed image comprising the exponential of the output image, the post-processed image
4 comprising the output image of the system.

1 11. A gradient domain compression method of generating, from an input image having a high
2 luminance dynamic range, an output image having a lower luminance dynamic range, the method
3 comprising:

4 A. a gradient image generator step of generating, from the input image, a gradient image
5 representing, for respective points of the input image, gradient values in the luminance of the
6 input image;

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- 7 B. a gradient compression step of receiving the gradient image and generating a compressed
3 range gradient image in which the range of gradient values are compressed; and
- 9 C. an output image generator step of receiving the compressed range gradient image and
1 generating therefrom an image, the image generated during the output image generator step
1 comprising the output image.

1 12. A method as defined in claim 11 in which the gradient compression step comprises:

- 2 A. a gradient attenuation function generator step of generating, for respective points in the
3 gradient image, a gradient attenuation function whose value for respective points in the
4 gradient image is configured to reduce the range of gradient values in the gradient image; and
- 5 B. an attenuated image gradient generator step of generating, from the gradient image and the
5 gradient attenuation function, the compressed range gradient image.

1 13. A method as defined in claim 12 in which the gradient attenuation function generator step
2 includes the step of generating the gradient attenuation function to provide values for respective
3 points of the gradient image so as to reduce relatively high gradient values in a progressive manner,
4 such that higher gradient values are reduced more than lower gradient values.

1 14. A method as defined in claim 12 in which the gradient attenuation function generator step
2 includes the step of generating the gradient attenuation function to provide values for respective
3 points of the gradient image so as to increase relatively low gradient values in a progressive manner,
4 such that lower gradient values are increased more than higher gradient values.

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1 15. A method as defined in claim 12 in which the gradient attenuation function generator step
2 includes the step of generating the gradient attenuation function whose value for respective points
3 in the gradient image is configured to reduce the range of gradient values in the gradient image
4 around a selected gradient value in the gradient image.

1 16. A method as defined in claim 12 in which the gradient attenuation function generator step
2 comprises:

- 3 A. a Gaussian pyramid generator step of generating a Gaussian pyramid comprising a series of
4 levels, each level of the Gaussian pyramid comprising a level gradient image having a
5 reduced resolution than the level gradient image of the preceding level in the series;
- 5 B. a level scaling factor generator step of generating, for respective levels gradient images of
7 the Gaussian pyramid, a respective level scaling factor representative of the gradient
3 attenuation function at the particular level; and
- 9 C. a scaling factor propagator step of propagating module the level scaling factors through the
9 Gaussian pyramid, thereby to generate the gradient attenuation function for use during the
1 attenuated image gradient generator step.

1 17. A method as defined in claim 11 in which output image generator step includes the step of
2 generating the output image as the image that is close to the compressed range gradient image in a
3 least-squares sense.

1 18. A method as defined in claim 17 in which the output image generator step includes the step of
2 generating the output image in such that the Laplacian of the output image corresponds to the
3 divergence of the compressed range gradient image.

1 19. A method as defined in claim 11 further comprising a preprocessor step of generating, in
2 response to the input image, a preprocessed image comprising the logarithm of the input image, the
3 gradient image generator step making use of the preprocessed image as its input image.

1 20. A method as defined in claim 11 further comprising a post-processor configured configured to
2 generate, in response to the output image generated by the output image generator module, a post-
3 processed image comprising the exponential of the output image, the post-processed image
4 comprising the output image of the method.

1 21. A computer program product for use in connection with a computer to provide a gradient domain
2 compression system for generating, from an input image having a high luminance dynamic range,
3 an output image having a lower luminance dynamic range, the computer program product
4 comprising a computer-readable medium having encoded thereon:

- 5 A. a gradient image generator module configured to enable the computer to generate, from the
5 input image, a gradient image representing, for respective points of the input image, gradient
7 values in the luminance of the input image;
- 3 B. a gradient compression module configured to enable the computer to receive the gradient
3 image and generate a compressed range gradient image in which the range of gradient values
3 are compressed; and
- 1 C. an output image generator module configured to enable the computer to receive the
2 compressed range gradient image and to generate therefrom an image, the image generated
3 by the output image generator module comprising the output image.

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1 22. A computer program product as defined in claim 21 in which the gradient compression module
2 comprises:

- 3 A. a gradient attenuation function generator module configured to enable the computer to
4 generate, for respective points in the gradient image, a gradient attenuation function whose
5 value for respective points in the gradient image is configured to enable the computer to
6 reduce the range of gradient values in the gradient image; and
7 B. an attenuated image gradient generator module configured to enable the computer to
8 generate, from the gradient image and the gradient attenuation function, the compressed
9 range gradient image.

1 23. A computer program product as defined in claim 22 in which the gradient attenuation function
2 generator module is configured to enable the computer to generate the gradient attenuation function
3 to provide values for respective points of the gradient image so as to reduce relatively high gradient
4 values in a progressive manner, such that higher gradient values are reduced more than lower
5 gradient values.

1 24. A computer program product as defined in claim 22 in which the gradient attenuation function
2 generator module is configured to enable the computer to generate the gradient attenuation function
3 to provide values for respective points of the gradient image so as to increase relatively low gradient
4 values in a progressive manner, such that lower gradient values are increased more than higher
5 gradient values.

1 25. A computer program product as defined in claim 22 in which the gradient attenuation function
2 generator module is configured to enable the computer to generate the gradient attenuation function
3 whose value for respective points in the gradient image is configured to enable the computer to

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4 reduce the range of gradient values in the gradient image around a selected gradient value in the
5 gradient image.

1 26. A computer program product as defined in claim 22 in which the gradient attenuation function
2 generator comprises:

3 A. a Gaussian pyramid generator module configured to enable the computer to generate a
4 Gaussian pyramid comprising a series of levels, each level of the Gaussian pyramid
5 comprising a level gradient image having a reduced resolution than the level gradient image
5 of the preceding level in the series;

7 B. a level scaling factor generator module configured to enable the computer to generate, for
3 respective levels gradient images of the Gaussian pyramid, a respective level scaling factor
9 representative of the gradient attenuation function at the particular level; and

1 C. a scaling factor propagator module configured to enable the computer to propagate the level
1 scaling factors through the Gaussian pyramid, thereby to generate the gradient attenuation
2 function for use by the attenuated image gradient generator module.

1 27. A computer program product as defined in claim 21 in which output image generator module is
2 configured to enable the computer to generate the output image as the image that is close to the
3 compressed range gradient image in a least-squares sense.

1 28. A computer program product as defined in claim 27 in which the output image generator module
2 is configured to enable the computer to generate the output image in such that the Laplacian of the
3 output image corresponds to the divergence of the compressed range gradient image.

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1 29. A computer program product as defined in claim 21 further comprising a preprocessor module
2 configured to enable the computer to generate, in response to the input image, a preprocessed image
3 comprising the logarithm of the input image, the gradient image generator module being configured
4 to enable the computer to use the preprocessed image as its input image.

1 30. A computer program product as defined in claim 21 further comprising a post-processor module
2 configured to enable the computer to generate, in response to the output image generated by the
3 output image generator module, a post-processed image comprising the exponential of the output
4 image, the post-processed image comprising the output image of the system.